

THE CLAIMS

What is claimed is:

1. A ion-implanted photoresist removal composition, comprising at least one supercritical fluid (SCF), at least one co-solvent, and at least one reducing agent.
2. The removal composition of claim 1, wherein the SCF comprises a fluid selected from the group consisting of carbon dioxide, oxygen, argon, krypton, xenon, and ammonia.
3. The removal composition of claim 1, wherein the SCF comprises carbon dioxide.
4. The removal composition of claim 1, wherein the co-solvent comprises at least one C₁-C₆ alcohol.
5. The removal composition of claim 1, wherein the co-solvent comprises isopropanol (IPA).
6. The removal composition of claim 1, wherein the reducing agent comprises at least one of formic acid, hydrogen gas, formaldehyde, formalin, boranes, diboranes, amine stabilized boranes, amine stabilized alanes, and tetraalkyl amines of BH₄ and AlH₄.
7. The removal composition of claim 6, wherein the reducing agent comprises formic acid.

8. The removal composition of claim 1, wherein the SCF-based removal composition comprises about 60.0 wt % to about 90.0 wt % SCF, about 10.0 wt % to about 30.0 wt % co-solvent, and about 0.01 wt % to about 5.0 wt % reducing agent, based on the total weight of the composition.
9. The removal composition of claim 8, wherein the SCF comprises carbon dioxide.
10. The removal composition of claim 8, wherein the co-solvent comprises at least one C₁-C₆ alkanol.
11. The removal composition of claim 8, wherein the reducing agent comprises at least one of formic acid, hydrogen gas, formaldehyde, formalin, boranes, diboranes, amine stabilized boranes, amine stabilized alanes, and tetraalkyl amines of BH₄ and AlH₄.
12. A method of removing ion-implanted photoresist from a substrate having same thereon, said method comprising contacting the substrate having the ion-implanted photoresist thereon with an SCF-based composition comprising at least one SCF, at least one co-solvent, and at least one reducing agent, for sufficient time and under sufficient contacting conditions to remove the ion-implanted photoresist from the substrate.
13. The method of claim 12, wherein the SCF comprises a fluid selected from the group consisting of carbon dioxide, oxygen, argon, krypton, xenon, and ammonia.

14. The method of claim 12, wherein the SCF comprises carbon dioxide.
15. The method of claim 12, wherein the contacting conditions comprise pressure in a range of from about 1500 psi to about 4500 psi.
16. The method of claim 12, wherein said contacting time is in a range of from about 1 minutes to about 20 minutes.
17. The method of claim 12, wherein the co-solvent comprises at least one C₁-C₆ alcohol.
18. The method of claim 12, wherein the co-solvent comprises isopropanol (IPA).
19. The method of claim 12, wherein the reducing agent comprises at least one of formic acid, hydrogen gas, formaldehyde, formalin, boranes, diboranes, amine stabilized boranes, amine stabilized alanes, and tetraalkyl amines of BH₄ and AlH₄.
20. The method of claim 12, wherein the reducing agent comprises formic acid.
21. The method of claim 12, wherein the SCF-based composition comprises about 60.0 wt % to about 90.0 wt % SCF, about 10.0 wt % to about 30.0 wt % co-solvent, and about 0.01 wt % to about 5.0 wt % reducing agent, based on the total weight of the composition.
22. The method of claim 12, wherein the contacting step comprises a cycle including (i) dynamic flow contacting of the SCF-based composition with the substrate having the ion-implanted photoresist, and (ii) static soaking contacting

of the SCF-based composition with the substrate having the ion-implanted photoresist thereon.

23. The method of claim 22, wherein said cycle comprises alternately and repetitively carrying out dynamic flow contacting (i) and static soaking contacting (ii) of the substrate having the ion-implanted photoresist thereon.
24. The method of claim 12, further comprising washing the substrate, at a region at which the ion-implanted photoresist has been removed, with a SCF/isopropanol water wash solution in a first washing step, and with a SCF in a second washing step, to remove residual precipitated chemical additives in said first washing step, and to remove residual precipitated chemical additives and/or residual alcohol in said second washing step.
25. The method of claim 24, wherein the SCF comprises SCCO_2 .
26. The method of claim 12, wherein the contacting conditions comprise temperature in a range of from about 50°C to about 90°C.
27. The method of claim 12, wherein the photoresist was exposed to a high-dose ion-implantation process, wherein the high-dose ion implantation rate is greater than 1×10^{15} atoms/cm².